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REPORT OF SURVEY CONDUCTED AT

GTE
GOVERNMENT SYSTEMS CORP
C^3 SYSTEMS SECTOR

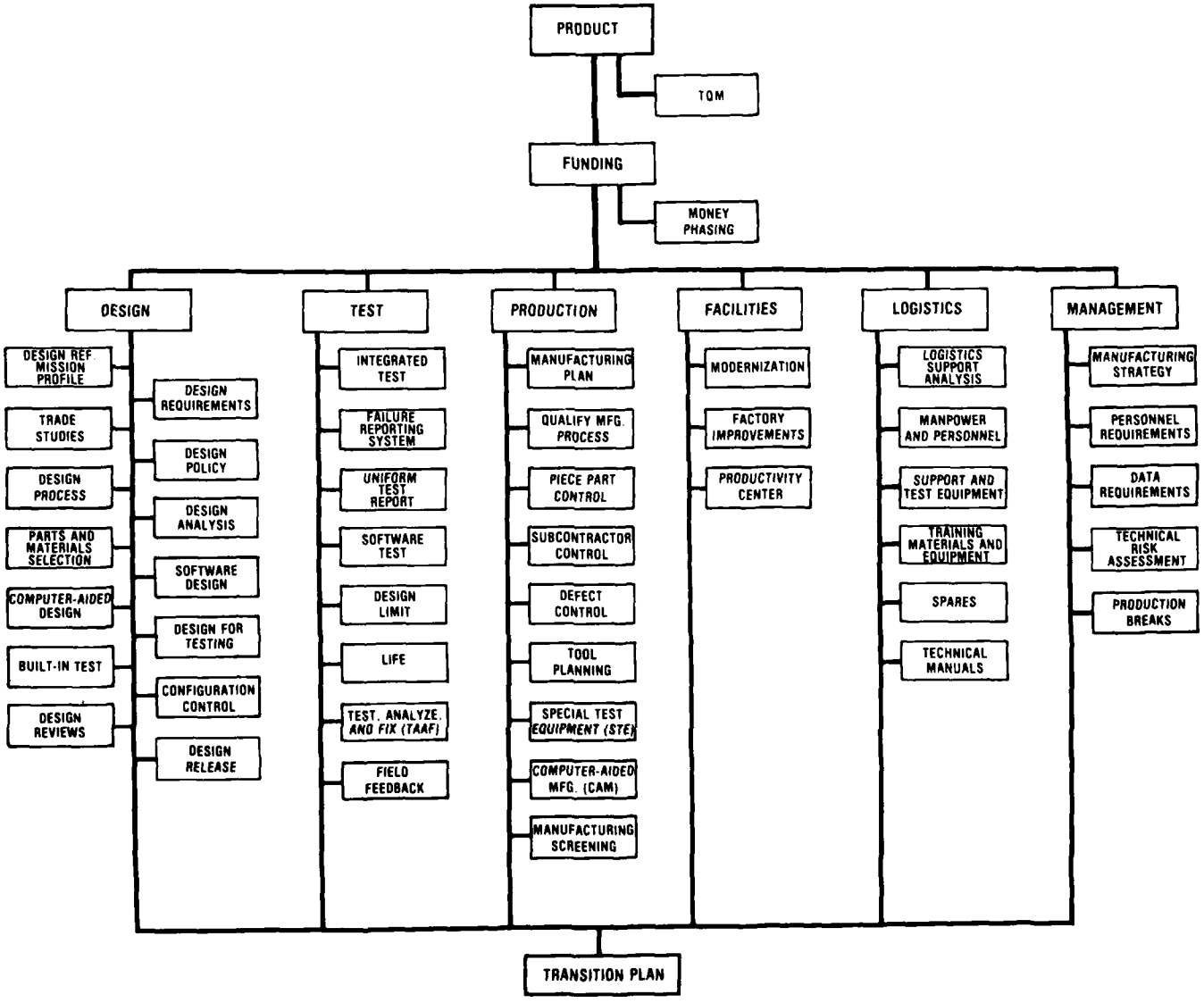
NEEDHAM HEIGHTS, MASSACHUSETTS

NOVEMBER 1988

DoD 4245.7-M

"TRANSITION FROM DEVELOPMENT TO PRODUCTION"

CRITICAL PATH TEMPLATES



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The purpose of the Best Manufacturing Practices (BMP) survey conducted at this facility was to identify their best practices, review manufacturing problems, and document the results. The intent is to extend the use of progressive management techniques as well as high technology equipment and processes throughout the U.S. industrial base. The actual exchange of detailed data will be between contractors at their discretion. A company point of contact is listed in the report

The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.

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SECTION 1

EXECUTIVE SUMMARY

The Best Manufacturing Practices (BMP) team conducted a survey at GTE, Government Systems Corporation, Command, Control, and Communications Systems (C^3 Systems) Sector in Needham Heights, Massachusetts. The purpose of the survey was to review and document the best practices and potential industry-wide problems at GTE C^3 Systems. The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.

1.1 KEY FINDINGS

There were many best practices observed at GTE C^3 Systems that are detailed in this report. Some of the more significant findings included in this report are listed below:

SECTION 2

INTRODUCTION

2.1 SCOPE

The purpose of the Best Manufacturing Practices (BMP) survey conducted at GTE Government Systems Group, Command, Control, and Communications Systems (C^3 Systems) Sector was to identify best practices, review manufacturing problems, and document the results. The intent is to extend the use of progressive management techniques as well as high technology equipment and processes throughout industry. The ultimate goal is to strengthen the U.S. industrial base, solve manufacturing problems, improve quality and reliability, and reduce the cost of defense systems.

To accomplish this, a team of Navy engineers, supported by a representative of the Army and NASA, accepted an invitation from C^3 Systems to review the most advanced manufacturing processes and techniques used in their facilities located in Needham Heights, Massachusetts. Manufacturing problems that had the potential of being industry wide problems were also reviewed and documented for further investigation in future BMP surveys. The review was conducted on 14-18 November 1988 by the team identified in Appendix B of this report.

The results of BMP surveys are entered into a data base to track best practices and manufacturing problems. The information gathered is available for dissemination through an easily accessible central computer. The actual exchange of detailed data will be between contractors at their discretion.

The results of this survey should not be used to rate C^3 Systems among other defense electronics contractors. A contractor's willingness to participate in the BMP program and the results of a survey have no bearing on one contractor's performance over another's. The documentation in this report and other BMP reports is not intended to be all inclusive of a contractor's best practices or problems. Only selected non-proprietary practices are reviewed and documented by the BMP survey team.

2.2 SURVEY PROCESS

This survey was performed under the general survey guidelines established by the Department of the Navy. The survey concentrated on the functional areas of design, test, production, facilities, logistics, and management. The team evaluated C^3 Systems' policies, practices, and strategies in these areas. Furthermore, individual practices reviewed were categorized as they relate to the critical path templates of the DoD 4245.7-M, "Transition From Development To Production." GTE C^3 Systems identified potential best practices and potential industry wide problems. These practices and problems and other areas of interest identified were discussed, reviewed, and documented for dissemination throughout the U.S. industrial base.

The format for this survey consisted of formal briefings and discussions on best practices and problems. Time was spent on the factory floor reviewing practices, processes, and equipment. In-depth discussions were conducted to better understand and document the practices and problems identified.

2.3 NAVY CENTERS OF EXCELLENCE

Demonstrated industry wide problems identified during the Best Manufacturing Practices surveys may be referred to one of the Navy Manufacturing Technology Centers of Excellence. They are:

Automated Manufacturing Research Facility (AMRF)
Gaithersburg, MD

Applied research in the machining processes, within a heterogenous Computer Integrated Manufacturing environment

Electronics Manufacturing Productivity Facility (EMPF)
Ridgecrest, CA

Applied research in the processes and materials involved in the manufacture of circuit card assemblies

Metalworking Technology Incorporated (MTI)
Johnstown, PA

Applied research in the metalworking processes

2.4 GTE GSC C^3 SYSTEMS OVERVIEW

GTE Government Systems Corporation (GSC) is a major supplier of customized systems for defense, government, and industry in the United States and abroad. GSC consists of three major sectors. The Electronic Defense Sector is headquartered in Mountain View California. The Tactical Systems Sector is headquartered in Taunton Massachusetts. The Command, Control, and Communications Sector (C^3 Systems) is in Needham Heights, Massachusetts and was the location selected for this BMP survey.

C^3 Systems capabilities encompass a complete spectrum from systems engineering and architecture, software intensive systems design, utilization of artificial intelligence, and the total integration of information systems, to hardware design, manufacturing, installation, training, logistics support, operation, and maintenance.

2.5 GTE GSC C^3 SYSTEMS POINT OF CONTACT

While the information included in this report is intended to be descriptive of the best processes and techniques observed at GTE GSC C^3 Systems, it is not intended to be all inclusive. It is anticipated that the reader will need more detailed data for true technology transfer.

The point of contact for this BMP survey is:

Mr. Irv Shapiro
Director, Product Assurance
(617) 455-5010

GTE
Government Systems Corporation
Command, Control, & Communications
Systems
77 "A" Street
Bldg. #23
Needham Heights, MA 02194

Mr. Shapiro's cooperation, time, and quality of effort in preparation and hosting of this survey at GTE C^3 Systems and participation in the Best Manufacturing Practices Program is greatly appreciated.

SECTION 3

BEST PRACTICES

The practices listed in this section are those identified by the BMP survey team as having the potential of being among the best in the electronics industry.

3.1 DESIGN

DESIGN FOR PRODUCIBILITY

GTE C^3 Systems has experienced common problems in the area of producibility. Design concepts are often formulated with little thought given to producibility. Problems such as designs not being consistent with current manufacturing technology or not being compatible with in-house capabilities were often encountered. To solve this problem, C^3 Systems has implemented a producibility engineering group within their operations (manufacturing) department. This group is tasked with:

Developing producibility design guidelines
Developing design standards
Performing producibility planning
Performing producibility design reviews

The producibility group provides manufacturing experts who become part of the design team very early in the development cycle. Producibility engineering is an on-going activity throughout the design phase of the project. Those manufacturing engineers who were involved in the design also take an active role in the process of releasing the design for production.

INCORPORATION OF APPLICATION SPECIFIC INTEGRATED CIRCUITS

GTE C^3 Systems characterizes itself as primarily a systems design activity. Therefore, it was interesting to note their extensive use of internally developed Application Specific Integrated Circuits (ASICs).

Their microelectronics center has designed approximately 300 ASICs using cell families developed on their parent company's Fast Automatic Layout of MOS Integrated Circuits (FAMOS) program. Process technology ranges from 5 micron to 1.2 micron geometries. A variety of foundaries are used for wafer fabrication. The number of chips observed in inspection, bonding, and test was adequate evidence that the microelectronics center is a well utilized resource.

Organizationally, the microelectronics center is responsible for manufacture of ASICs and hybrids as well as design. This has resulted in a high degree of integration between design and manufacturing and extensive use of the design database to automate manufacturing processes.

Personnel stated that size is no longer the main driving force behind the decision to use an ASIC design. Performance and enhanced functionality are now the main drivers. This aggressive use of ASIC technology offers the Government increased performance. It also provides for future growth as well as expanded markets for the system products of the C^3 Systems organization.

SOFTWARE QUALITY ORGANIZATION

The organization which is tasked with software quality assurance has been situated within the the Advanced Technology Department within Engineering. The advantages of placing this function in Engineering as described by GTE C^3 Systems are:

> Better technical personnel can be attracted to the engineering department to perform software quality assurance work. These individuals understand that they will be involved in software development, not solely acting as inspectors.
>
> By directly contributing to software development efforts from a quality assurance aspect, the adversarial inspector role is avoided.
>
> The quality assurance personnel are dedicated to quality awareness evaluation, problem avoidance, and problem solving while being co-located with the development group.

SOFTWARE QUALITY ASSURANCE

GTE C^3 Systems has taken an innovative approach to Software Quality Assurance (SQA) by placing the SQA organization within the Advanced Technology Department within Engineering. SQA's apparent loss of organizational independence is largely compensated for by the enormous technical benefit of interacting directly with the software production for building a quality product. In addition, the Advanced Technology Department is primarily focused on software engineering tools, technology transition, and software issues as well as software quality.. With this relationship, SQA is also able to attract and retain a staff which is technically oriented and experienced with software development. The loss of independence is only apparent as SQA still functionally reports to the product assurance staff organization when serious deficiencies may not be resolved through normal channels.

SQA has taken a lead role in technical evaluations and is able to focus on design quality. Documentation is reviewed not merely for formal consistency and adherence to standards, but also for the soundness of the design. The design is verified and problem areas are identified. SQA may then propose some solutions.

The quality evaluation program is based on the analysis of metrics collected on the project using the Structured Techniques for Engineering Projects (STEP) database. Various automated graphics tools, including Excel, Mac Chart, and Mac Draw, are used to interpret the metrics collected for each life cycle phase. For example, the function allocation tracking is verified by analysis of the architecture charts for the preliminary design phase. Discrepancy management is supported by the Trouble and Change Report, directly produced by Structured Techniques for Engineering Projects (STEP) in the detailed design phase. During testing, software integration charts allow the performance of critical analysis. Risk analysis is conducted by STEP, which automatically tabulates the sizing of the software components. Significant departure from the baseline size is a definite indicator of risk.

The metrics approach to SQA has already proven to be a very effective method to measure improved quality. It is also cost effective as it allows the correction of discrepancies early in the cycle. By using metrics, C^3 Systems was able to demonstrate that extensive testing at the unit level reduces significantly the incidence of errors detected at system integration.

STRUCTURED TECHNIQUES FOR ENGINEERING PROJECTS (STEP)

GTE C^3 Systems has developed an environment to support the software engineering process. Structured Techniques for Engineering Projects (STEP) is an interactive computer environment supported by a network of microcomputers (Macintosh) connected through a Local Area Network (LAN) to server minicomputers (VAX/VMS, MicroVax/VMS). STEP has been proven over ten years of use on projects developed in various languages (Fortran, Pascal, C, Assembly, CMS-2, etc.). It is consistent with government standards. The STEP supports the ADA language and automated documentation tools for DOD-STD-2167A/2168. The STEP system is a combination of human procedures, tools, a database, and an interactive computer environment, which automates the activities of:

Software engineering
Software quality assurance
Configuration control
Project management

A distinguished feature of STEP is the implementation of a hierarchical architecture which incorporates principles essential to the design of quality software. STEP establishes a common methodology which achieves the benefits of reliable, supportable software, with each project based on a proven architecture. This results in quality improvement and cost effectiveness.

Another distinguishing feature of STEP is the project visibility and control provided throughout the software development cycle. The STEP metrics and development data base provides inputs to tools that automate the various activities of software management such as software quality assurance, project schedule, cost and status, and configuration control of all software parts. Also, STEP enforces compliance with methodology and standards by requiring the use of processes provided by the system for design and documentation. The three levels of testing (design, unit, and system integration) are easily controlled by STEP, which keeps track of test input, procedure, and output while allowing for further manual or automated analysis.

Overall, STEP is a methodology and associated automated software development environment which results in an orderly, controlled, and structured software engineering process which can be quantified and measured. From the STEP data base, metrics are developed and reported to provide managers with current and accurate information, which can be used to make sound operating decisions. As a next step, GTE C^3 Systems is extending its data and metrics analysis to learn to predict expected software errors.

SOFTWARE ENGINEERING INSTITUTE

Engineering management at GTE C^3 Systems is committed to keeping abreast of advances in software design and test methodologies. This is best evidenced by the continuous funding of a GTE liaison representative at the Software Engineering Institute at Carnegie Melon University. GTE C^3 Systems management feels that such academic associations are key to achieving their present software engineering process goals. This affiliation also provides an information resource for pursuing software reuse methods, tools applications, and technology transition.

COMMUNICATIONS SYSTEM SEGMENT REPLACEMENT (CSSR) PROJECT

"You only control what you can measure." This could be the motto of the GTE C^3 Systems' approach to the development of the Communications System Segment Replacement (CSSR), a current Air Force program. The mission is a communications hub for the defense of North America. The requirements are stringent in terms of functionality, performance, and design. The equipment is comprised of STRATUS processors, a GTE Technical Control System, operator consoles, and VAX computers. A maximum use of commercial off-the-shelf hardware and software is required. The application software is 350K Lines-Of-Code (LOC) developed and a total of 710K LOC, including reused code.

Three of GTE C^3 Systems' best software practices are implemented in CSSR.

The architecture is designed under the Structured Techniques for Engineering Projects (STEP II) environment.

Metrics are used extensively for project management and software process control.

A rigorous quality assurance practice is in place.

The software architecture is designed in the STEP II environment and is based on existing, well established software architecture which GTE C^3 Systems has developed for previous applications. The architecture becomes the driving factor in the project and directs the engineering organization structure which maps it. For instance, the size of the software team is determined by the software component size. The re-use architecture approach is a contributing factor to risk and cost containment.

Parametric cost models (COCOMO and JENSEN) are used along with expert estimates to identify the driving cost areas. Decisions are then made to reduce the effort and automate the process.

Data analysis and metrics evaluation allow for early problem detection and corrective action. For instance, a lag in actual integration tests performed versus the number of tests currently planned may be corrected by (1) reducing the number of tests performed - some tests may be redundant, or (2) increasing the size of the test team which may have been underestimated.

A post mortem on the project may quantify the cost effectiveness of the metrics approach. However, C^3 Systems already demonstrated on some components that quality increases may be measured and correlated to the intensity of unit testing.

DESIGN METHODOLOGY HANDBOOKS

Software Engineering of GTE C^3 Systems has documented policies, procedures, and methodologies in a series of handbooks. The hierarchical structure of these handbooks is unique. Procedures have been broken down into a series of handbooks covering individual functions. Users receive only those sections they need in order to perform their current assignment. Users are more likely to be receptive to an approach that gradually broadens their perspective than one which buries them from the outset in a morass of detail.

A conscious attempt is also made to keep the handbooks as straightforward as possible to maintain compactness. These handbooks were developed on Macintosh personal computers and their format and use of graphics is similar to that used in Macintosh manuals. Potential users of these handbooks are involved in the review cycle.

NETWORKING AND DATA INTEGRATION

GTE C^3 Systems' Microelectronics Center has achieved a high level of data integration. This integration has been accomplished through the effective use of computer networking, a strong management commitment to data sharing, and effective planning.

The Microelectronics Center possesses a large variety of computer hardware including VAX and Apollo computers, a Zycad simulation accelerator, a Calma Graphics system, and Versacad plotters. All of these systems are linked by various networks permitting the free flow of data. This data path has permitted the implementation of a common database which resides on a VAX cluster. The data in this system is controlled using Oracle database management software. The data is used to provide design verification tools, parts and materials data, and integrate all functional units within the center.

Some significant advantages of this system are:

Schematics created on Mentor Graphics workstations are used as an information source to drive a number of other tools, such as logic simulation and circuit layout tools.

Design libraries used for simulation are consolidated and controlled.

Design processes can be managed through the use of on-line checklists, user guides, and mandated tools.

Location of network resources are transparent to the user.

Node use and disk space are monitored on-line.

Backups are performed over the network for all nodes.

MICROELECTRONICS CENTER

The microelectronics center is equipped with a variety of state-of-the-art software tools, all of which run on two basic platforms, the digital equipment VAX and the Apollo. More important is the software that C^3 Systems has developed to provide the user with a set of integrated tools.

At the heart of this capability are 30 Apollo DN 3000's and DN 4000's distributed throughout the C^3 Systems campus. These computers are equipped with schematic capture and simulation software from Mentor Graphics. Zycad LE 1004 and FE 1004 simulators are provided as a network resource for acceleration of simulation. Mentor's boardstation product is being developed as a physical layout tool for hybrid substrates. This design front end feeds a number of VAX 11/750 and 11/785 computers used for database management, place and route, library storage, etc.

One of the tools used at C^3 Systems is a SILCSYN logic synthesizer from SILC Technologies. SILC Technologies was founded by former GTE employees and GTE retains an interest in SILC. Starting with a LISP-like description of the operation of a function, SILCSYN synthesizes the logic necessary to implement the function in terms of a particular family of logic cells. Ultimately, SILCSYN produces actual schematics, which directly interface with the schematic capture software of the target CAE system. One thing that differentiates SILC Technology from its competitors is the ability to synthesize sequential as well as combinational logic.

GTE C^3 Systems intends to use SILCSYN to synthesize large macro functions, which can be imported into Mentor Graphic's chipgraph and cellgraph products for development of more complex integrated circuits.

An example was shown of a fairly short two page description of a complex circle generation circuit, which was expanded by SILCSYN into a 19 page Mentor schematic.

The overall philosophy of the microelectronics center is to provide tools to systems designers that allow them to perform the design and simulate Applications Specific Integrated Circuits (ASICs). The microelectronics center retains responsibility for the platforms, tools network, and the actual physical layout process of the ASIC chip. The microelectronics center also provides database management of ASIC designs of archiving (using a new 2.3 Gigabyte Helical Scan Tape Cartridge). Software has also been developed to determine machine and disk utilization to allow the best administration of these resources.

The microelectronics center is also equipped with the necessary assets for die and wire bonding, package capping, and testing of ASICs. A GENRAD GR-16 is used for ASIC testing. The microelectronics center also produces screen-and-fired ceramic substrates. Of particular interest is the trace 901D bed-of-nails tester, which is used to test substrates that any of the quad robotic pick-and-place system uses.

ACCOUNTABILITY FOR DESIGN CHANGES

GTE C^3 Systems is implementing a change to their configuration control process to better track the source of design and documentation problems. The present drawing change control form contains a block giving five reasons for making the change. They are:

Drafting error
Design error
Design change
Customer
Other

These reasons did not provide enough detail for trend analysis to determine if a problem existed in a functional organization; i.e., drafting, checking, etc.

A new design change form contains 21 reasons for a change. Included are such items as:

Inadequate design review
Inadequate design analysis
Inadequate simulation
Vendor problems
Cost/schedule improvement
New program/project requirements

The detail provided by this additional information will allow for better insight into the problems and improved corrective actions.

3.2 PRODUCTION

PRODUCIBILITY REVIEWS

Manufacturing Engineering at GTE C^3 Systems is an integral part of the design review process for producibility issues. Manufacturing must approve the design at each step in the design review process. A producibility handbook has been developed to assist in the producibility reviews. Standard component lists have been established to assist in making the product as producible as possible and to minimize costs. The design team tours the manufacturing areas that will be used in producing the product to establish the capabilities and limitations of the production areas. During these tours a much needed interchange of information takes place between the shop floor personnel and design engineering. Some of the benefits realized since implementing this program are:

Increase in automatic insertion of components from 60% to 92%.

Reduction of card nest costs by a factor of 16 on one program.

Reduction of cable harness assembly costs by 25% to 30%.

There have been no Engineering Change Notices (ECNs) generated on one program since it went into production.

MATERIAL INFORMATION DATA SYSTEM (MIDAS)

GTE C^3 Systems, in an effort to maintain adequate controls over their immense material management system, has developed a data system known as the Material Information Data System (MIDAS). This is a totally integrated data system which was designed to intensively manage the following areas.

Engineering Data Control - This provides a real time control over documentation and Engineering Change notices. The substantial reduction in time realized in revising changes from engineer to operator has resulted in reduced scrap rates in some areas.

Material Procurement and Control - This system was designed to track and control material from initial requisition through its acceptance into inventory.

Quality Data System - This reflects real time quality data from in-process assembly inspection to final test, providing information on rejection rates and rework time.

Manufacturing Planning and Control - Known as 'MOPAC' provides full scale planning and control capabilities for internal manufacturing efforts. This portion of MIDAS has the ability to track material through the various assembly work centers.

3.3 FACILITIES

EQUIPMENT MODERNIZATION

A computer numerically controlled lathe has replaced six lathes that were previously used at GTE C^3 Systems. Cost savings have resulted from reduced errors, less setup time, and more repeatability from one part to the next. A laser plotter system is in place for making printed wiring board artwork. The system has reduced errors due to the previous step and repeat process and panel artwork can now be completed in three minutes versus the previous eight hours or longer.

COMPUTER INTEGRATED ENTERPRISE

GTE C^3 Systems has established the Computer Integrated Enterprise (CIE) program. The objective of this program is to through computer technology and integration, improve business, engineering, and manufacturing processes, thereby improving productivity, quality, and decreasing the cost of doing business.

CIE is tasked with looking at GTE's business strategies for the 90's and aligning information systems to complement these strategies. This effort to integrate information systems in engineering, manufacturing, and finance is critical to achieving the full benefits of their information resources.

3.4 LOGISTICS

INTEGRATED LOGISTICS APPROACH

A soon-to-be-released Integrated Logistics Support (ILS) Handbook is under development which defines specifics of engineering responsibilities and details the LSA process. GTE C^3 Systems accesses an Air Force lessons-learned database which has been useful in developing the ILS handbook. The database contains summary reports of lessons learned in may areas including computer resources, reliability/maintainability, training, life cycle cost, test and evaluation, etc.

An on-line logistics reference system provides technical, cost, contract, and logistics information on the 13 million part numbers in the federal supply system. Using this tool, they have developed equipment lists for Non-Developmental Item (NDI) hardware selection, tools and test equipment lists, parts related data for preparation of supply support program documentation, and data for performing trade-off analysis for concept definition studies.

Projects draw from a staff of 24 logistics engineering experts, which are assigned as required, usually in the proposal stage. Available logistics decision support tools include cost trade-offs, impact operations, and support resource requirements. Artificial intelligence systems are being brought on-line to provide interactive simulation, prediction, and other support resources.

RAMCAD CONCURRENT ANALYSIS

A reliability prediction program, based on MIL-HDBK-217D/E, has been merged with an in-house generated thermal analysis program to form a concurrent design analysis tool. The integration of the two programs has allowed optimization of device placement on circuit boards for optimum reliability while maintaining junction temperature derating criteria. This has allowed an early entry of design analysis tools into the design cycle at an earlier phase than usual. Enhancements for user friendliness are being examined, stimulating expanded useage.

The development of integrated analysis tools is a joint venture with the University of Maryland in the area of techniques research sponsored by the National Science Foundation and is an ongoing program in the area of automated reliability and maintainability tool development, as well as other areas of interest (conductive cooling, layout optimization, redundancy allocation, etc.)

RAMCAD GLOBAL DATABASE APPROACH

A global database containing reliability and maintainability data has been generated which allows designers to have immediate access to material selection information at their personal workstations. An existing system, known as MIDAS (Material Information Data System), was developed in-house at GTE C^3 Systems and contains numerous data, including material procurement status, incoming inspection data, parts lists approved for programs, status of parts approval, and acceptable parts substitutes. This system is being expanded into a global reliability and maintainability parts data base.

Use of the expanded system by designers will reduce problems associated with Reliability and Maintainability Reviews at a point in the design cycle which causes redesign problems. It also contains an electronic mail system which enhances communication between designers and logistics support personnel. Use of this system has reduced the number of audits in the area of parts usage prior to completion of approval cycle because parts can be tracked so easily using the parts control database.

DESKTOP PUBLISHING RESOURCES

GTE C^3 Systems has a staff of over 60 people involved in technical publications. Both text and full color graphics are produced through "desktop" publishing techniques. A broad range of products, from commercial advertising copy to proposals and technical manuals, is produced by this facility. Technical manuals for systems such as Peacekeeper, Minuteman, and Launch Control Center (LCC) are typical products. Quantities of over 800 copies of technical manuals have been run although quantities are usually smaller. The output can be delivered via laser printer, typesetter, or electronic media.

An impressive assortment of equipment is available to scan hardcopy text and graphics, 3-D models, and print color documents. All major equipment is connected to the GSC network, which interfaces with over 1,000 Macintosh computers.

GTE C^3 Systems has been active in the Computer-Aided Acquisition and Logistics Support (CALS) initiative and is prepared to supply output in the CALS standardized format.

3.5 MANAGEMENT

RISK ASSESSMENT CLOSEOUT PROCEDURE

The risk control plan starts with the proposal and has provisions to allow risk assessment items to be followed until a formal closeout approval has been obtained. The action items on the risk assessment are reviewed and updated every two weeks. Each satisfied item is then carried once more on the risk assessment report and shows when it was formally closed out. This eliminates misunderstandings which occur when a risk item is dropped from the list immediately upon closeout, which may confuse the customer's program manager who is tracking risk items on the list. An informal copy of this internal report is supplied to the customer.

PROGRAM MANAGEMENT

The proposals and project plans at GTE C^3 Systems are written by the anticipated program manager utilizing other prospective team members in their areas of expertise. This type of management practice allows an allocation of resources to be made at the earliest possible point in the program. Forecasting of risk assessment and needs for scarce skill resources are identified at the earliest possible stage. A unique level of continuity is achieved and time is utilized better at the front end of the program. This method eliminates many of the problems which arise in the early stages of a new program between the program office and resource management.

QUALITY USING EMPLOYEE SUPPORT TEAM (QUEST)

As an effort to improve overall quality and productivity, GTE C^3 Systems has developed and implemented a program known as Quality Using Employee Support Team (QUEST). This is a comprehensive program that integrates three of the following elements to achieve manufacturing excellence throughout the facility:

Total Quality Control (TQC), which provides continuous update training in various manufacturing techniques to both the local employee and GTE's subcontractors. Also, under TQC is the implementation of an effective Statistical Process Control (SPC) program which will be phased in over a three year period.

Continuous Flow Manufacturing (CFM), which was established to reduce overall inventories of supplies and finished goods throughout the manufacturing facility. Utilizing the team approach, which encompasses management as well as assembly personnel, CFM has recognized significant reductions in assembly time along with a substantial increase in productivity.

Vendor Involvement Program, which was developed to enhance C^3 Systems' ongoing quality program, utilizes an extensive vendor rating system, which is based on specific quality data criteria. The vendor involvement program has also initiated a dock to stock program to reduce overall inspection, material handling, and stock inventory.

STANDARDIZED PROGRAM MANAGEMENT APPROACH

GTE C^3 Systems has developed a standardized program management approach which begins as the program plan is in the proposal stage. Once it has been written, this same document becomes the program management plan and is used as a handbook desk reference for the program manager and staff. It contains tool selection in such areas as scheduling, performance measurement, finance, etc. and aids in managing the program. It emphasizes the concept of task teams as an objective, which allows skill sharing, cooperation on joint programs, standardized approaches, reduced costs, and improved program performance.

The program management handbook also serves as course material for a training program in which approximately 100 program staff personnel are trained. These program management plans/handbooks are always written, regardless of whether or not it is required by contract.

CUSTOMER COMMUNICATION

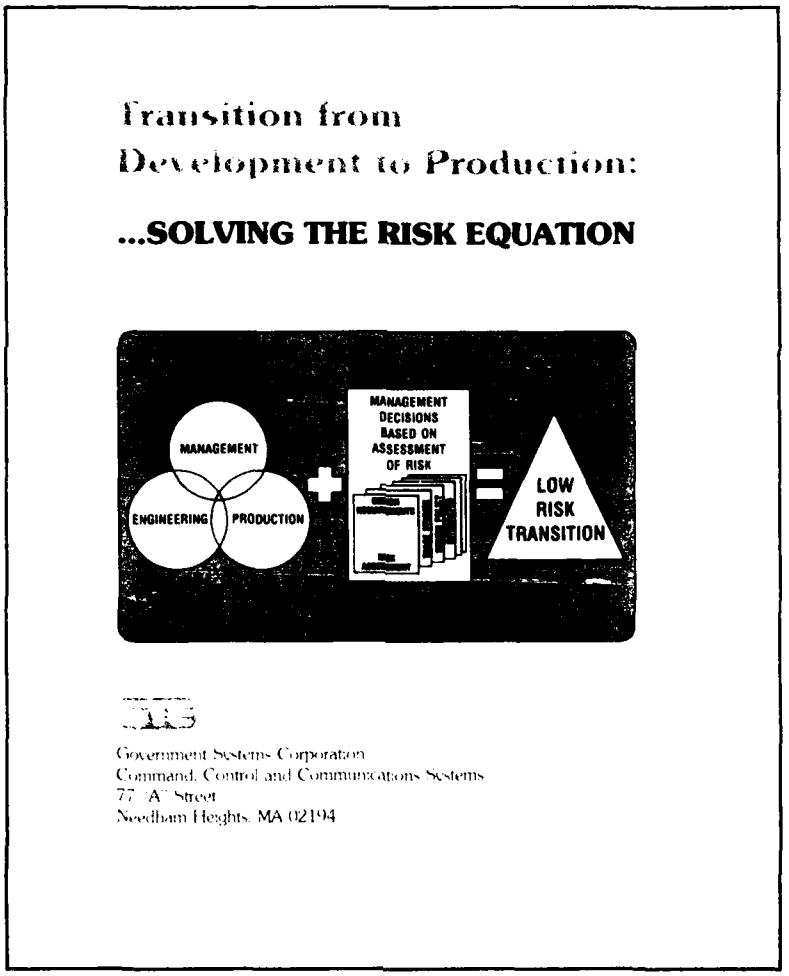
GTE C^3 Systems strongly supports frequent, informal customer contact as a key to program success. Direct telephone communications between project engineers, program managers, and the customers are encouraged. Some program issues may require daily communications to keep the information flow current. Although detailed documentation of all communications must be generated and routed through the Program Manager, the frequent and informal contact promotes a non-adversarial relationship with the customer and makes dealing with major issues easier.

3.6 TRANSITION PLAN

TRANSITION AND RISK ASSESSMENT GUIDELINES

GTE C^3 Systems is committed to implementing the concepts of DoD 4245.7-M and NAVSO P-6071. Backround and training in the transition process is evidenced in many areas of their operation. Data is collected and metrics are used that will ultimately improve product design or the design and manufacturing processes.

They have developed and published transition guidelines in nine risk areas: Program Planning and Funding, Designing for Low Risk, CAD/CAM, Test and Test Design, Design Reviews, Failure Analysis, New Manufacturing Processes, Integrated Logistics Support, and Software Design and Test.



SECTION 4

PROBLEM AREAS

4.1 LOGISTICS

OUTDATED LSA TOOLS REQUIRED BY GOVERNMENT

Each service has its own set of tools (repair level analyses, life cycle cost models, etc.) which forces contractors to spend time learning and maintaining the capability to use each program.

Also, the government tool set is even less integrated than the contractors and is based on outdated methodologies and technologies making it very difficult to integrate them into the contractor's system. More up-to-date database management systems and open system architectures are required.

LSA CONTRACT REQUIREMENTS FOR NDI

Contract requirements for Logistic Support Analysis (LSA) on Non-Developmental Item (NDI) hardware and software are often inconsistent and unrealistic. Application of the same requirements to both developed and non-developed items within the same product can lead to difficulties in the ability or the resources required to meet those specifications.

APPENDIX A

TABLE OF ACRONYMS

Acronym	Definition
ASIC	Application Specific Integrated Circuits
BMP	Best Manufacturing Practices
C^3	Command, Control, and Communications
CAE	Computer-Aided Engineering
CALS	Computer-Aided Logistics Support
CFM	Continuous Flow Manufacturing
CIE	Computer Integrated Enterprise
CSSR	Communications System Segment Replacement
ECN	Engineering Change Notice
FAMOS	Fast Automatic Layout of MOS Integrated Circuits
GSC	Government Systems Corporation
ILS	Integrated Logistics Support
LAN	Local Area Network
LCC	Launch Control Center
LOC	Lines of Code
LSA	Logistics Support Analysis
LSI	Logistics Support Integration
MIDAS	Material Information Data System
MOPAC	Manufacturing Planning and Control
NASA	National Aeronautics and Space Administration
NDI	Non-Developmental Item
QUEST	Quality Using Employee Support Team
RAMCAD	Reliability, Availability, and Maintainability Computer-Aided Design
SPC	Statistical Process Control
SQA	Software Quality Assurance
STEP	Structural Techniques for Engineering Projects
TQC	Total Quality Control

APPENDIX B

BMP REVIEW TEAM

Team Member	Agency	Role
Alan Criswell (215) 897-6684	**Naval Industrial Resources Support Activity** Philadelphia, PA	**Team Chairman**
Ed Turissini (317) 353-7965	**Naval Avionics Center** Indianapolis, IN	**Team Leader** Design/Test
Dave Zeph (317) 353-7961	**Naval Avionics Center** Indianapolis, IN	
Claudia Barton (619) 553-3376	**Naval Ocean Systems Center** San Diego, CA	
Larry Robertson (812) 854-1694	**Naval Weapons Support Center** Crane, IN	**Team Leader** Production/Facilities
Paul Marmino (201) 532-0068	**US Army Laboratory Command** Fort Monmouth, NJ	
Jerry Sergeant (309) 782-7800	**US Army Industrial Engineering Activity** Rock Island, IL	**Team Leader** Management/Logistics
Lois Scaglione (216) 433-2352	**NASA Lewis Research Center** Cleveland, OH	

APPENDIX C

PREVIOUSLY COMPLETED SURVEYS

BMP surveys have been conducted at the companies listed below. Copies of survey reports for any of these companies may be obtained by contacting:

Best Manufacturing Practices Program
Office of the Assistant Secretary of the Navy
(Shipbuilding and Logistics)
Attn: Mr. Ernie Renner, RM&QA
Washington, DC 20360-5000
Telephone: (202) 692-0121

COMPANIES SURVEYED

Litton
Guidance & Control Systems Division
Woodland Hills, CA
October 1985

Texas Instruments
Defense Systems & Electronics Group
Lewisville, TX
May 1986

Harris Corporation
Government Support Systems Division
Syosset, NY
September 1986

Control Data Corporation
Government Systems Group
Minneapolis, MN
December 1986

ITT
Avionics Division
Clifton, NJ
September 1987

UNISYS
Computer Systems Division
St. Paul, MN
November 1987

General Dynamics
Forth Worth Division
Fort Worth, TX
May 1988

Honeywell, Inc.
Underseas Systems Division
Hopkins, MN
January 1986

General Dynamics
Pomona Division
Pomona, CA
August 1986

IBM Corporation
Federal Systems Division
Owego, NY
October 1986

Hughes Aircraft Company
Radar Systems Group
Los Angeles, CA
January 1987

Rockwell International Corporation
Collins Defense Communications
Cedar Rapids, IA
October 1987

Motorola
Government Electronics Group
Scottsdale, AZ
March 1988

Texas Instruments
Defense Systems & Electronics Group
Dallas, TX
June 1988

Hughes Aircraft Company
Missile Systems Group
Tucson, AZ
August 1988

Bell Helicopter
Textron, Inc.
Fort Worth, TX
October 1988

Litton
Data Systems Division
Van Nuys, CA
October 1988

Information gathered from all BMP surveys is included in the Best Manufacturing Practices Management Information System (BMP-MIS). Additionally, a calendar of events and other relevant information are included in this system. All inquires regarding the BMP-MIS may be directed to:

Director, Naval Industrial Resources Support Activity
Attn: BMP-MIS System Administrator
Bldg. 75-2, Room 209, Naval Base
Philadelphia, PA 19112-5078
Telephone: (215) 897-6684